

**THE ROLE OF INTRAPARTUM INTRAVENOUS THERAPY AND  
METHOD OF DELIVERY ON NEWBORN WEIGHT LOSS:  
CHALLENGING THE 7% RULE**

by

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## ABSTRACT

It is common practice to initiate supplemental feeding in newborns if body weight decreases by 7-10% in the first few days after birth (7-10% rule). Standard hospital procedure is to initiate intravenous therapy once a woman is admitted to give birth. However, little is known about the relationship between intrapartum intravenous therapy and the amount of weight loss in the newborn. The present research was undertaken in order to determine what factors contribute to weight loss in a newborn, and to examine the relationship between the practice of intravenous intrapartum therapy and the extent of weight loss post-birth. Using a cross-sectional design with a systematic random sample of 100 mother-baby dyads, we examined properties of delivery that have the potential to impact weight loss in the newborn, including method of delivery, parity, duration of labour, volume of intravenous therapy, feeding method, and birth attendant. This study indicated that the volume of intravenous therapy and method of delivery are significant predictors of weight loss in the newborn ( $R^2=15.5$ ,  $p<0.01$ ). ROC curve analysis identified an intravenous volume cut-point of 1225 ml that would elicit a high measure of sensitivity (91.3%), and demonstrated significant Kappa agreement ( $p<0.01$ ) with excess newborn weight loss. It was concluded that infusion of intravenous therapy and natural birth delivery are discriminant factors that influence excess weight loss in newborn infants. Acknowledgement of these factors should be considered in clinical practice.

## LIST OF ABBREVIATIONS

<b><math>\alpha</math></b>	Alpha
<b>ANOVA</b>	Analysis of variance
<b>GERD</b>	Gastroesophageal reflux disease
<b>GTPAL</b>	<i>Gravida</i> – number of times pregnant <i>Term</i> – number of babies carried to term (37+ weeks) <i>Premature</i> – number of babies delivered prior to 37 weeks <i>Abortion</i> – number of spontaneous or planned abortuses <i>Live</i> – number of live infants
<b>IV</b>	Intravenous
<b>OB/GYN</b>	Obstetrician and gynecologist
<b>PCOS</b>	Polycystic ovarian syndrome
<b>PIH</b>	Pregnancy induced hypertension
<b>ROC curve</b>	Receiver operator characteristic curve

## DEFINITIONS

### ***Cohen's Kappa analysis***

A measure of agreement for categorical data.

### ***Gravida***

The number of the pregnancy that a woman is in; "in her third pregnancy a woman is said to be gravida three" or the total number of times a women has been pregnant during her lifetime.

### ***Intrapartum***

The time from the onset of true labor until the delivery of the infant and placenta.

### ***Oxytocin***

Medication used to induce and or enhance labour.

### ***Prevalence***

The number of people with a specific condition in a given population.

### ***Primiparity (primip, primiparous)***

First time infant delivery.

### ***ROC curve analysis***

A graphic means for assessing the ability of a screening test to discriminate between healthy and diseased persons.

### ***Sensitivity***

A measure of the usefulness of a classification scheme. Sensitivity is the probability that a "positive" case is correctly classified, and is plotted on the y-axis in an ROC curve. 1-sensitivity is the false negative rate.

### ***Specificity***

A measure of the usefulness of a classification scheme. Specificity is the probability that a "negative" case is correctly classified. 1-specificity is the false positive rate, and is plotted on the x-axis in an ROC curve.

## CHAPTER 1- INTRODUCTION

### 1.1 Preamble

Infants are given breast milk substitutes in the hospital shortly following birth for various reasons, including significant dehydration, hypoglycemia, maternal illness, medications that are contraindicated in breastfeeding, congenital deformation of the infant, delayed lactogenesis, hyperbilirubinemia, *or if they have lost greater than 7-10 percent of their body weight since birth* (Alder, Williams, Anderson, Forsyth, Florey and Van der Velde, 2004.; Bruce and Griffioen, 1995; Hamilton Health Sciences, 2005; ILCA, 2005; S. Coulas personal communication, 2005). While in some cases, supplementation is necessary, the practice of supplementation based on weight loss alone, with no other criteria, can result in undermining the mother's confidence in her ability to breastfeed. While the "7-10 percent weight loss rule" has long been in place, it was instituted when there were fewer interventions in the hospital pertaining to childbirth. Although national guidelines have been written based on this "rule of thumb", there is, in fact, little scientific evidence to support the widespread use of this protocol.

Weight loss in the newborn is a normal physiologic process, as the neonate adjusts to life outside the womb. The evidence suggests that the body composition of the newborn changes significantly in the first few days of life as total body water and total body solids are lost (Rodriguez, Ventura, Samper, Morreno, Sarria and Perez-Gonzalez, 2000).). Since there is very little evidence examining the composition of the weight loss in the newborn, further studies



need to be undertaken to determine the various factors that influence both body weight at birth and body weight losses shortly after birth.

Previous evidence indicates positive correlations between the method of delivery and the incidence of weight loss in newborns. Infants born by urgent caesarian section tend to lose a greater amount of weight than those born by spontaneous vaginal delivery. Correlations exist between medications given during labour and the amount of weight lost. However, to date there has been no evidence that specifically looks at the role of intravenous therapy during labour and newborn weight loss.

## **1.2 Objectives**

The primary objective of this study was to examine the role of intrapartum intravenous therapy and the method of delivery on newborn weight loss. A secondary objective was to establish a positivity criterion of intravenous volume as a discriminant measure for predicting excess weight loss in newborn infants.

## **1.3 Hypothesis**

It is hypothesized that the method of delivery and intravenous therapy will influence newborn weight loss.

## **CHAPTER 2 – REVIEW OF LITERATURE**

### **2.1 Introduction**

A review of the literature was conducted to determine the existing evidence with respect to newborn weight loss in the first week postpartum, early supplementation, and the duration of breastfeeding; newborn weight loss and use of intravenous therapy and/or medications during labour and delivery; as well as compositional changes in newborns in the first few days of life.

The search involved electronic as well as hand searching peer reviewed journals. Databases including CINAHL and OVID were searched using keywords, such as labour, birth weight, weight loss, newborn weight loss, neonatal weight loss, newborn/neonatal body weight/composition, newborn supplementation, supplementing newborns, intravenous therapy, intravenous therapy newborn/neonatal hyponatremia, delayed lactation (lactogenesis). It was expected that all evidence would have been reported within the past 10 years; however, several articles of importance would have been excluded using this strategy, and therefore, the search was expanded to include any relevant article regardless of age. In doing so, it became clear that there are significant gaps in the literature in this area, and that there is a need for more current research with respect to this topic as some of the existing evidence is quite dated.

### **2.2 Weight Loss in Newborn Infants**

Several studies have shown variances in reported weight loss. DeMarzo, Seacat and Neifert (1991) reported a weight loss of up to 14.3% by day 5, and that the

weight loss exceeded 7% in 9% of the infants they studied. Manganaro, Mami, Marrone, Marseglia and Gemelli (2001) reported that 8% of breastfed infants lost an amount equal to, or greater than, 10% of their initial birth weight, with the maximal weight loss occurring by day 3-4 post-birth. Dewey, Nommsen-Rivers, Heinig and Cohen (2003) defined excess weight loss as a decrease equal to or greater than 10% of birth weight by day 3; they found that 12% of breastfeeding infants had excessive weight loss, and that 52.6% of the infants lost over 5% of their birth weight. Interestingly, two studies based in the United Kingdom showed significantly less weight loss than those in North America. Wright and Parkinson (2004) stated that average weight loss was 4-7% of birth weight, but acknowledged that there is limited normative data on neonatal weight loss. MacDonald, Ross, Grant and Young (2003) completed a large study of 937 infants, including all methods of delivery, and both breast fed and formula fed infants. Infants were weighed at birth and again before discharge at 48 hours. They concluded that the median weight loss for all infants was 5.9%. In a personal communication with Dr. MacDonald, it was asked whether it is standard practice in the United Kingdom, to initiate intravenous therapy when a woman is admitted to deliver, and if not, under which circumstances would intravenous therapy be given. His response was that intravenous therapy is given during operative deliveries, it is rarely used in routine vaginal deliveries, and it is used only sparingly in inductions and augmentations of labour (P. MacDonald, personal communication, 2006). These two reports further support the

hypothesis that intravenous therapy may indeed be associated with higher levels of weight loss in the newborn following birth.

Previous research has shown that one circumstance under which intravenous therapy is given is correlated with weight loss in the newborn, namely caesarean section. Manganaro, Mami, Marrone, Marseglia and Gemelli (2001) found that 77% of infants born by caesarean section had a weight loss of equal to, or greater than, 10% of their birth weight. Kulski, Smith and Hartmann (1981) also found similar results. Further supporting these reports are the data from Dewey, Nommsen-Rivers, Heinig and Cohen (2003) in which it was found that 29% of infants born by urgent caesarean section had excessive weight loss (defined as >10% weight loss), and that 25% born by scheduled caesarean section also had excessive weight loss; on the other hand, only 11% of assisted vaginal births and 10% of spontaneous vaginal births showed excessive weight losses. Dewey, Nommsen-Rivers, Heinig and Cohen (2003) also collected data on labour medications, and found that if no pain management was received, 8% of infants had excessive weight loss, whereas if regional anaesthesia was given along with intravenous medication, 26% of infants had excessive weight loss. They found that the correlation between labour medications and excess weight loss existed after controlling for confounders. Dewey, Nommsen-Rivers, Heinig and Cohen (2003), in the same study, also concluded that there was a 2.4 fold greater risk of excess weight loss in mothers with a labour longer than 14 hours, and that a significant correlation exists between weight loss and primiparity. Dewey, Nommsen-Rivers, Heinig and Cohen (2003) suggested the following

reasoning for this finding - the longer labour often incurred by primiparous women put them at greater risk of having interventions, such as oxytocin, epidural anaesthesia, or caesarean sections. These studies again suggest a relationship between the interventions routinely utilized during labour and delivery and infant weight loss.

### **2.3 Weight Loss and Supplementation**

The significance of weight loss in a new born is important due to the fact that weight loss is an indicator for supplementation. Often included in many hospital protocols and discharge criteria, and in fact, written in the National Guidelines for when supplementation should be offered, is the so-called  $\geq 7\%$  weight loss rule. However, no evidence has been found to substantiate the rule. If we are to be giving care dependent on evidence-based practice, then any protocol used as common practice needs to be based on research evidence that is both current and comprehensive.

Few studies have examined the relationship between newborn weight loss and intravenous therapy. Dahlenburg, Burnell and Braybrook (1980) looked specifically at the infusion of 5% Dextrose to labouring women; they found that infants whose mothers received the intravenous therapy lost 6.17% in the first 48 hours, compared to 4.07% in the group who received no intravenous therapy. Battaglia, Prystowsky, Smison and Hellegers (1960) (reported in Dahlenburg, Burnell and Braybrook, 1980) reported that the infusion of 5% dextrose decreased the serum sodium levels of the mother, which as a result of the forces of osmotic pressure, led to a fluid shift to the fetus, which in turn resulted in a

subsequent increase in the baby's body weight and a lowering of the serum sodium levels. These results support the notion that a greater weight loss may be the result of the mother receiving intravenous therapy.

#### **2.4 Changes in birth weight and water loss in newborn infants**

Few studies have examined the time course and compositional changes that comprise the weight loss in the newborn infant. Rodriguez, Venture, Samper, Moreno, Saria and Perez-Gonzalez (2000) used bioelectrical impedance to determine the changes in body composition of 43 newborns during the first 3 days of life. Body weight was measured on the first, second, and third day of life, at the same time each day; the results indicated that body weight, total body water, and total body solids progressively decreased during that time period. Although this study confirmed that there is a significant total body water loss in the first 3 days of life, the researchers did not look at any specific variable to see its impact on these changes. Therefore, further research should be undertaken to determine those factors that influence infant body weight at birth and the losses in body weight that occur shortly after birth.

#### **2.5 Hypernatremia and body weight loss in newborns**

Laing and Wong (2002) were interested in the increasing incidence of hypernatremia in newborns. Through their work, it was found that plasma sodium concentrations in infants were raised as a result of the loss of extracellular fluid, and that the loss of the extracellular fluid was associated with a decreased fluid intake and an excessive fluid loss. There was also indication that hypernatremia

was more common in the infants of primiparous women (Laing and Wong, 2002; Moritz, Manole, Bogen and Ayus, 2005). Manganaro, Mami, Marrone, Marseglia and Gemelli (2001) noted similar frequencies of hypernatremia in newborns, and reported a higher incidence of caesarean section in those infants with hypernatremia. MacDonald, Ross, Grant and Young (2003) determined through their research that mild hypernatremia (146-150 mmol/l) was found throughout all levels of weight loss, but that there was a significant correlation with excess weight loss. Based on the literature, further research is required to determine potential reasons for excessive fluid losses in order to prevent hypernatremia in newborns.

## **2.6 Delivery, medication and weight loss in newborn infants**

Several studies have pointed out the fact that very little research has been completed regarding weight loss in newborns (Dewey, Nommsen-Rivers, Heinig and Cohen, 2003, Wright and Parkinson, 2004). Wright and Parkinson cited quite eloquently that “postnatal weight loss is a well known but little studied phenomenon” (p.255). While previous studies have reported that caesarean section delivery is associated with excess newborn weight loss, there have not been any recent studies that looked specifically at the use of intravenous therapy during labour and delivery for all types of deliveries.

## **2.7 Summary**

The results of this literature review strongly indicate that the proposed research is needed if we are to clarify some of the issues regarding the incidence of newborn weight loss.

In this study, it is hypothesized that the use of intravenous therapy during labour increases the hydration status of the newborn as a result of a fluid shift from the mother to the infant, and that this fluid shift results in a higher registered birth weight for the infant. The infant then proceeds to progressively lose total body water as previous studies have shown, which also puts the infants at an increased risk for hypernatremia. Further, the loss of the excess fluid inflates the total percentage of body weight lost, and as a result, there is an increased chance that the infant may be subsequently supplemented with formula, which as the evidence suggests, can lead to shortened breastfeeding durations.

This research could make significant contributions by providing evidence-based information related to the administration of intravenous fluids during the intrapartum period. Future research should aim to examine the potential cost savings to hospitals from changes in hospital protocols, such as the “7-10% rule”, limiting the administration of intravenous therapy, and the subsequent reduction in the number of re-admission for excessive weight losses and hypernatremic dehydration in newborns.



## **CHAPTER 3 - METHODS**

### **3.1 Design and sample**

To address our study objectives, we employed a cross sectional design in which 137 mother/baby charts were initially examined for exclusions. Criteria for exclusion included multiple births, delivery complications in the mother or the infant, intravenous insertion in the infant, admission to neonatal intensive care, nasogastric feeds, malformations in the infant such as cleft lip or palate, or prematurity of less than 36 weeks. A final sample of 100 mother/baby dyads, delivered at Hamilton Health Sciences, McMaster University Medical Centre site in Hamilton, Ontario Canada, were systematically examined to develop a database for secondary analysis.

### **3.2 Data collection**

An evaluation tool (Appendix 1) was designed to include various factors that previous studies have shown to have a potential to influence weight loss in the newborn. In the preparation of the data collection and evaluation tool, specialists in the field were consulted for advice on additional factors identified as being possible confounders. In the end, the data collection and evaluation tool consisted of 90 items of data and information.

In addressing confidentiality, the ID number of the infant's chart was used as an identifier. Once data was collected electronically and entered into the database, all identifying factors were removed from the data collection tools, and

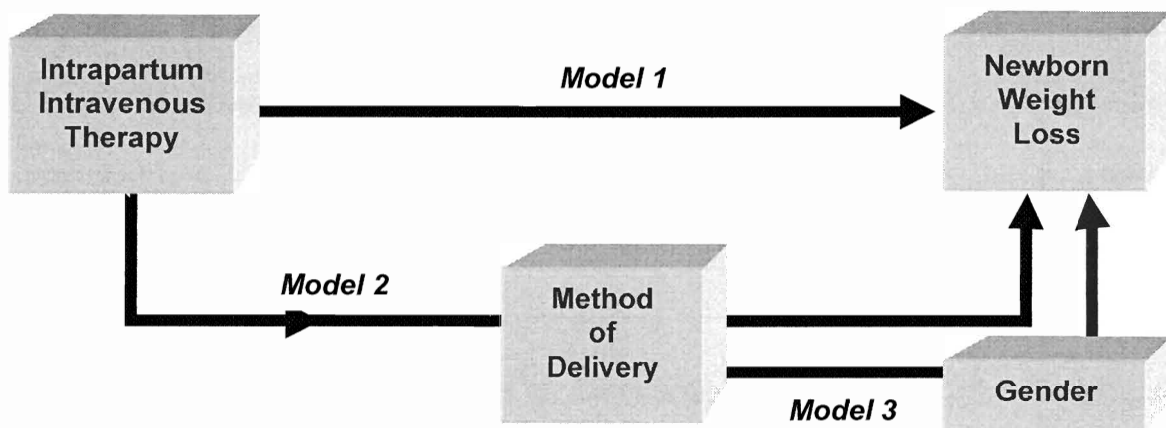
the completed tools were stored in a combination locked safe in the researcher's home. The study has received approval from both the Hamilton Health Sciences - McMaster University Research Ethics Board (Appendix 2) and the Brock University Research Ethics Board (Appendix 3).

### **3.3 Statistical analyses**

All statistical analyses were performed using SPSS (version 16). Descriptive statistics and a one-way analysis of variance were calculated for parametric measures, including gravida, labour duration, intravenous volume and duration, birth weight, absolute and relative weight loss. Chi-square analysis determined significant differences among non-parametric measures, including newborn gender, delivery method, delivery attendant, and choice of epidural, induction and/or intravenous therapy.

In order to examine the primary objective of the study, we used a stepwise multiple linear regression analysis. Three regression models were tested (Figure 3.1). We examined the explained variance of intrapartum intravenous therapy on newborn weight loss (Model 1). This relationship was explored further via the addition of method of delivery in Model 2. Both models were adjusted for gender. Model 3 considered whether the effect of intrapartum intravenous therapy and method of delivery as predictors of newborn weight loss were different for boys and girls. All models were tested for multi-collinearity (variance inflation factor >10).

We utilized a receiver-operator characteristic (ROC) curve analysis to establish a positivity criterion (cut-point) for intravenous volume during intrapartum in predicting excess newborn weight loss. Cohen's Kappa analysis was used to evaluate the statistical accuracy of an intravenous volume with high sensitivity and low specificity in predicting excess newborn weight loss. The level of significance was set at  $\alpha=0.05$  for all analytic analysis.



**Figure 3.1 Illustration of the regression models**

## CHAPTER 4 - RESULTS

### 4.1 Sample characteristics

This cross sectional design incorporated secondary data analysis examining the role of intrapartum intravenous therapy and method of delivery on newborn weight loss in an attempt to examine the so-called “7-10% rule”. A systematic random sample of 100 newborns, including 53 males and 47 females served as the subject base for this study. Multiple birth infants, and those with significant complications during, or following, intrapartum, were excluded. The prevalence of excessive newborn weight loss ( $\geq 7\%$  relative body weight) within the first 72 hours postpartum was 46%.

We categorized relative weight loss in our sample to examine differences in delivery characteristics (Table 4.1). A Chi-square analysis was used to identify significant differences between weight loss groups and delivery method ( $p < 0.01$ ), epidural use ( $p < 0.01$ ), and intravenous use ( $p < 0.05$ ). There was a greater number of vaginal deliveries for newborns that exhibited a weight loss  $< 7\%$ , while more caesarean sections (emergency and planned) were performed in the delivery of newborns with weight loss  $\geq 7\%$ . Further, a disproportionate number of mothers that did not receive an epidural or intrapartum intravenous therapy, delivered newborns with a weight loss of  $\geq 7\%$  (note: this cell had a count less than the expected count of 5). Newborn gender, labour induction, delivery attendant, and feeding method were not significantly different between weight loss groups ( $p > 0.05$ ).

**Table 4.1 Intrapartum descriptives by newborn weight loss**

		Weight Loss <7% (N=54)	Weight Loss ≥7% (N=46)
Newborn gender	Male	32 (59.3%)	21 (45.7%)
	Female	22 (40.7%)	25 (54.3%)
Delivery method †	Vaginal	42 (77.8%)	22 (47.8%)
	Assisted vaginal	2 ( 3.7%) <sup>a</sup>	1 ( 2.2%) <sup>a</sup>
	Emergency C-section	5 ( 9.3%)	14 (30.4%)
	Planned C-section	5 ( 9.3%)	9 (19.6%)
Epidural †	Yes	41 (75.9%)	43 (93.5%)
	No	13 (24.1%)	3 ( 6.5%) <sup>a</sup>
Induction	Yes	19 (35.2%)	18 (39.1%)
	No	35 (64.8%)	28 (60.8%)
Delivery attendant	OB/GYN	45 (83.3%)	41 (89.1%)
	Midwife	6 (11.1%)	5 (10.9%)
	Resident	3 ( 5.6%) <sup>a</sup>	0 ( 0 %) <sup>a</sup>
Intravenous therapy*	Yes	44 (81.5%)	44 (95.7%)
	No	10 (18.5%)	2 ( 4.3%) <sup>a</sup>
Feeding method	Breastfed	37 (69.8%)	34 (73.9%)
	Breastfed and formula	9 (17.0%)	9 (19.6%)
	Formula	7 (13.2%) <sup>a</sup>	3 ( 6.5%) <sup>a</sup>

\* = significantly different ( $p < 0.05$ ) between weight loss <7% and ≥7%.

† = significantly different ( $p < 0.01$ ) between weight loss <7% and ≥7%.

<sup>a</sup> = cell has expected count less than 5.

## 4.2 Newborn delivery characteristics

Table 4.2 presents the newborn delivery characteristics by weight loss and for the entire sample. Analysis of variance found significantly less intravenous infusion volume in the mothers of newborns with <7% weight loss ( $p<0.01$ ). However, no significant difference was found in the duration of intravenous therapy between newborn weight loss groups (a trend ( $p=0.06$ ) was observed). While the initial birth weight was comparable in both newborn groups ( $p>0.05$ ), the absolute and relative weight losses were significantly different between the two groups ( $p<0.01$ ). Similarly, the duration of labour and gravida (number of pregnancies) were not significantly different between groups.

**Table 4.2 Newborn delivery characteristics by weight loss (mean  $\pm$  sd)**

	Entire Sample (N=100)	Weight Loss <7% (N=54)	Weight Loss $\geq$ 7% (N=46)
Gravida (#)	2.46 $\pm$ 1.51	2.46 $\pm$ 1.31	2.46 $\pm$ 1.73
Labour duration (min)	510 $\pm$ 318	463 $\pm$ 285	572 $\pm$ 352
Intravenous volume (ml) †	2054 $\pm$ 1269	1744 $\pm$ 1236	2417 $\pm$ 1222
Intravenous duration (min)	373 $\pm$ 292	324 $\pm$ 277	432 $\pm$ 302
Birth weight (g)	3478 $\pm$ 462	3426 $\pm$ 416	3540 $\pm$ 508
Absolute weight loss (g) †	235.9 $\pm$ 101.9	166.1 $\pm$ 64.3	317.8 $\pm$ 72.6
Relative weight loss (%) †	6.67 $\pm$ 2.61	4.73 $\pm$ 1.68	8.95 $\pm$ 1.35

† = significantly different ( $p<0.01$ ) between weight loss <7% and  $\geq$ 7%.

### 4.3 Explaining newborn weight loss

Table 4.3 reports the results of the regression analysis. We chose newborn weight loss, with a cut-off of 7% as our dependent variable. In Model 1, the main effect of intrapartum intravenous therapy on newborn weight loss was significant after adjusting for gender, and was found to explain 8.6% of newborn weight loss. Once method of delivery was entered in Model 2, the explained variance increased significantly ( $p < 0.01$ ), with the two variables accounting for 15.5% of the variance in newborn weight loss.

In Model 3, we examined whether the effect of intrapartum intravenous therapy and method of delivery in predicting newborn weight loss is different for male and female infants. The results indicate no significant differences by gender, although intrapartum intravenous therapy and method of delivery remained significant in this model (Table 4.3).

**Table 4.3 Multiple linear regression predicting newborn weight loss**

Variables	Model 1	Model 2	Model 3
IV therapy	0.000** (0.000)	8.148E-5* (0.000)	0.9893E-5* (0.000)
Gender	0.126 (0.098)	0.132 (0.095)	0.292 (0.192)
Delivery method		0.114** (0.041)	0.139* (0.058)
Gender * IV therapy			-5.284E-5 (0.000)
Gender * Delivery method			-0.059 (0.083)
Constant	0.200	0.140	0.085
<i>R-squared</i>	0.086	0.155	0.165

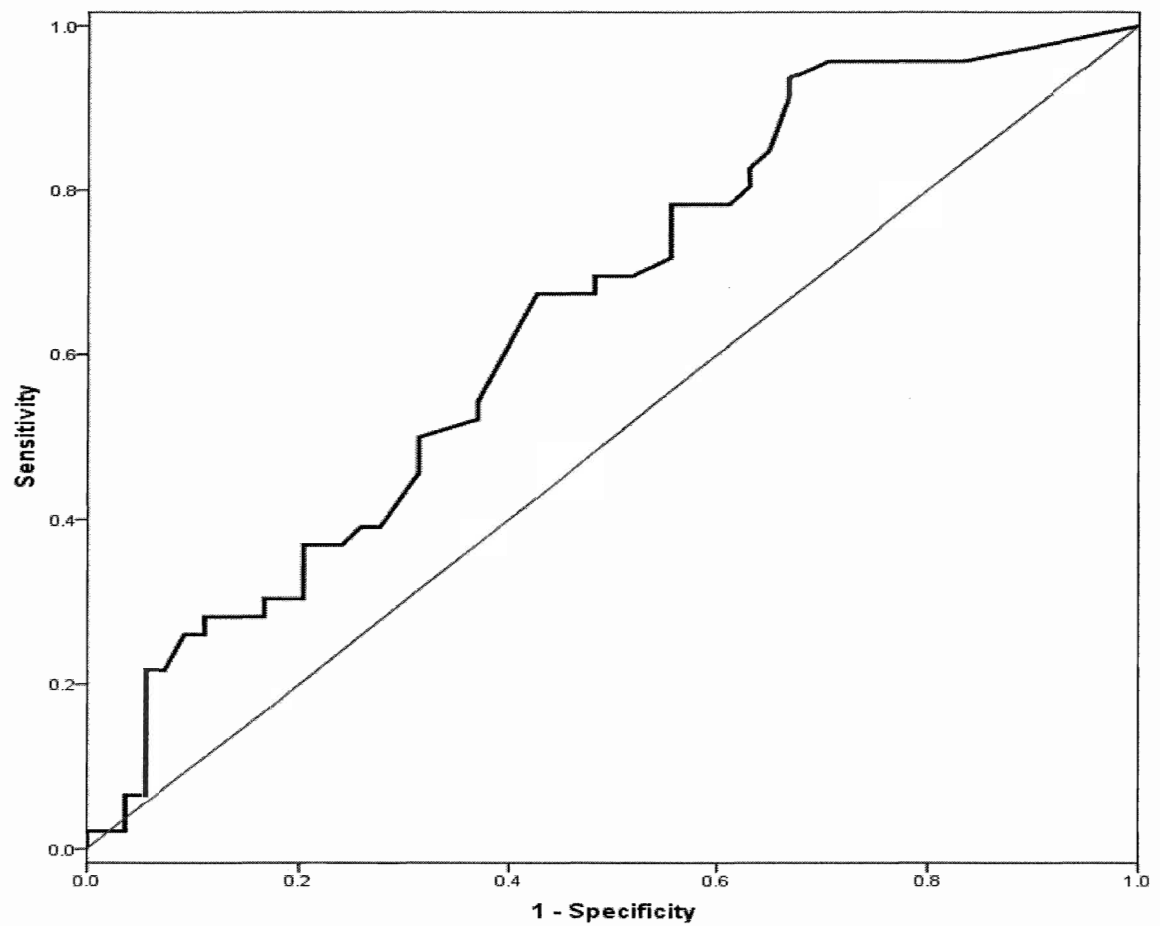
Unstandardized *b*-coefficients are reported with standard errors in parentheses.

\* $p < 0.05$ ; \*\* $p < 0.01$

#### **4.4 Establishing positivity criteria for establishing intravenous volume during intrapartum**

Receiver-operator characteristic (ROC) curve techniques were adopted to establish a positivity criterion for intravenous therapy during intrapartum. In this instance, a ROC curve provides a graphic means of assessing the ability of intravenous therapy to predict those at risk of excess newborn weight loss. The larger the area under the ROC curve, the more potent the discriminant ability of intravenous therapy, as this represents accurately identified cases (excess weight loss). The ROC curve for intrapartum intravenous volume, which illustrates the trade-off between sensitivity and specificity in determining the positivity criterion, is presented in Figure 4.1. The area under the curve (65%, with a CI of 54-76%) was significantly effective in identifying a condition of excess newborn weight loss ( $p < 0.01$ ). We chose to conservatively identify an intravenous volume cut-point of 1225 ml, which yielded a high measure of sensitivity (91.3%), while the specificity or the ability to identify those infants not at risk of excess weight loss was 33.3% (see Appendix 4). Cohen's Kappa analysis was used to evaluate the statistical accuracy of an intravenous volume of 1225 ml as an appropriate cut-point in predicting excess newborn weight loss. This cut-point demonstrated significant Kappa agreement ( $p < 0.01$ ) with excess newborn weight loss.





**Figure 4.1 Intrapartum intravenous volume ROC curve**

## CHAPTER 5 – DISCUSSION

### 5.1 Introduction

Newborn weight loss is a phenomena of which little is known. Based on a survey of available literature, it was determined that further research was warranted in order to support commonly used clinical practices and procedures that have been based on newborn weight loss. Early supplementation is one such practice that is undertaken when the weight loss of a new born infant is  $\geq 7\%$  of their birth weight (the so-called 7-10% rule). Therefore, it is important to have a thorough understanding of what factor(s) contribute to the weight loss in the newborn, and to gain a better understanding of those factors that might result in “excessive” weight loss. While previous studies have examined several factors/issues and various strategies as part of intrapartum intervention, there is a lack of evidence specifically examining the role of intravenous therapy in newborn weight loss.

The current study found that nearly one-half (46%) of the infants in the present study had a weight loss  $\geq 7\%$  of their birth weight. This prevalence was higher than that reported in European studies (MacDonald, Ross, Grant and Young, 2003; Wright and Parkinson, 2004; Rodriguez, Ventura, Samper, Morreno, Sarria and Perez-Gonzalez, 2000). It is interesting to note that if the weight loss cut-off had been set to 5% instead of 7% as has been reported in several previous studies, then 74% of the infants in our study would have been classified as having had excess weight loss compared to 52.6% in other studies (Dewey, Nommsen-Rivers, Heinig and Cohen, 2003). Discussion with a researcher in the United Kingdom revealed that intravenous therapy is not

routinely used for vaginal deliveries, and is used only sparingly in operative deliveries (personal communication, P. MacDonald, 2006).

## **5.2 Predicting excess newborn weight loss**

We determined that both the volume of intravenous therapy and the method of delivery are significant predictors of weight loss in a newborn. The overwhelming majority of pregnant women admitted to hospital received intravenous therapy prior to delivery. Intravenous therapy was received by 81.5% of women whose infants had a  $<7\%$  weight loss, and by 95.7% of women whose infants had a  $\geq 7\%$  weight loss. Specifically, mothers of infants that lost  $\geq 7\%$  body weight received significantly more intravenously-infused normal saline fluid compared to mothers of infants with a weight loss of  $<7\%$ . In addition, the volume infused was significantly correlated with an infant's post-birth weight loss. These findings suggest the greater volume of intravenous therapy infused to the mother increases the potential for the newborn infant to lose excess weight following delivery as a result of a fluid shift from the mother to the infant during the intrapartum period. While there was no significant difference in the duration of the intravenous infusion, the observed "trend" ( $p=0.06$ ) suggests that intravenous therapy flow rate, and the duration of intravenous therapy, warrants further examination.

Further examination of the data using a receiver-operator characteristic (ROC) curve analysis enabled us to determine those infants at risk for excessive weight loss. The area under the curve was significant, indicating that intravenous therapy exhibited discriminatory utility in predicting excess newborn weight loss.

Specifically, we found that an intravenous volume  $\geq 1225$  ml infused into the mother prior to delivery increases the probability of a  $\geq 7\%$  infant body weight loss within the first 3 days post-delivery by 91%. To our knowledge, there has been no previous literature that identifies the “critical” volume of intravenous therapy that would predict the probability for excess weight loss in a newborn infant. The high probability of excess weight loss in the infants of mothers that receive at least 1225 ml of saline might suggest that the birth weight of these children is artificially inflated. This result has significant implications for clinical practice. To prevent weight losses in excess of 7%, clinicians should plan carefully the use of intravenous therapy. If we are unable to limit the amount of intrapartum intravenous therapy to a level below the cut-point, clinicians should expect that an infant’s weight loss may very well exceed 7%, and should take this into account when looking at supplementation.

Current clinical practice guidelines and discharge criteria suggest supplementation with formula for exclusively breastfed infants who exhibit an excess weight loss (Health Canada, 2000; Hamilton Health Sciences, 2005). If this practice was adjusted, there may well be significant benefits for the mother, baby, and the hospital. If the infant is not supplemented, the mother’s confidence in her ability to successfully breastfeed is increased, which has in turn been previously shown to increase breastfeeding durations (Alder, Williams, Anderson, Forsyth, Florey and Van der Velde, 2004; Bruce and Griffioen, 1995; Chezem, Friesen and Boettcher, 2003; Cloherty, Alexander and Holloway, 2004). In addition, if the weight loss is limited to  $< 7\%$  body weight, then there will be less

risk of the infant developing hypernatremic dehydration and sub-optimal breastfeeding behaviors (Laing and Wong, 2002). Lastly, based on the results presented here, if the amount of intravenous therapy infused is limited to lesser amounts, the infants would be expected to lose less body weight, which in turn would positively impact hospital budgets in that less intravenous fluid will be used, less formula will be used as infants will not be supplemented on account of excess weight loss, fewer lab tests will be run, and there would be a reduction in the re-admission rate for infants with excess weight loss. Looking at the “bottom line”, in these days of tight fiscal budgets for hospitals, this research could indicate some future direction for further cost savings analysis.

Our study revealed a significant difference in the method of delivery between the weight loss groups. Vaginal deliveries accounted for a greater proportion of the infants in the <7% weight loss group, while caesarian deliveries (both scheduled and emergent) accounted for a larger proportion of the infants losing  $\geq 7\%$  of body weight. During vaginal births there are less medical interventions, specifically epidural or spinal anesthetics, which result in an increased volume of intravenous therapy being infused at the time of the birth. In our study, 75.9% of those in the <7% body weight loss group had an epidural, compared with 93.5% of those in the  $\geq 7\%$ . This finding was significant, and is important to note since the administration of anesthesia concurrently with intravenous therapy is a combination that poses a significant risk for excess body weight loss, and therefore should be closely monitored. However, it must be

acknowledged that specific conditions, which may have led to the decision to use a particular delivery method, may also impact weight loss.

### **5.3 Limitations**

A number of limitations should be recognized in this study. First, the results of this study lack external validity in that the study was conducted in a tertiary hospital-based facility, and therefore, was limited to a restricted number of practitioners, it is difficult to generalize the results beyond the environment in which the data were collected.

Second, while hospitals and practitioners follow specific clinical practice guidelines with regards to procedures, variations can exist between practitioners' data collection methods. Considering this study was undertaken some time following the infant births, no measure of quality control of patient hospital file information was possible. This is always an unavoidable systematic error in research that involves secondary data analysis of information not directly collected for study purposes.

Finally, a sizable number of deliveries by midwives were lost due to same day discharges and a lack of follow-up assessment of infant body weights. As a result, data from births involving midwives are not well represented in this sample. Although it is unknown how this limitation might have influenced the study results, it is a limitation that must be acknowledged, especially considering that the method of delivery was a significant predictor of newborn weight loss.

## 5.4 Conclusions

In the context of this study, the following conclusions were drawn:

1. Prevalence of weight loss was significantly higher in our study than that found in European studies. This result indicates that future research should be undertaken to identify differences between protocols in Europe and North America which may account for these variances.
2. A significant relationship exists between the volume of intravenous therapy infused, the method of delivery, and weight loss in the newborn. This information is significant in that the infusion of intravenous therapy at the time of delivery is a controllable action. Therefore, policies should be reviewed regarding the use of intravenous therapy, taking into account the issues of the potential significant impacts for the mother, the baby, and the hospital.
3. An infusion of  $\geq 1225$  ml of normal saline intravenous therapy during the intrapartum period increases the potential for the infant to lose  $\geq 7\%$  of its birth weight regardless of the duration of the infusion.
4. Infants who lost  $\geq 7\%$  of their birth weight weighed 3.6-8.6% more than those who lost  $\leq 7\%$  of body weight following birth. The heavier infants also received on average 673 ml more intravenous therapy than infants who lost  $\leq 7\%$  of their birth weight.
5. Deliveries by caesarean section, both planned and emergent, accounted for a larger number of infants in the  $\geq 7\%$  weight loss group. This result is consistent with the evidence in the literature. However, since the evidence also indicates the number of elective caesarean sections is steadily

increasing, attention needs to be paid to this result since this method of delivery poses a significantly increased risk for the infant to lost excessive weight.



## CHAPTER 6 – RECOMMENDATIONS FOR FUTURE RESEARCH

Based on this study, the following are recommendations for future research.

1. The significant difference in the percentage weight loss in newborns in North America and Europe needs to be explored to ascertain if the disparity is due to variations in protocol and/or procedures.
2. A prospective study examining sodium levels pre-, intra- and post-partum in the mother, and post-birth in the infant may lend to a further understanding of the fluid and electrolyte balance's role in weight loss in the newborn and the incidence of hypernatremia.
3. Further studies examining the benefits and risks of administering a reduced volume of intravenous therapy at the time of epidural initiation should be undertaken to determine if anesthetic protocols can be safely adjusted.
4. A larger scale, multi-site study should be undertaken to add external validity to this study. This study should include capturing pertinent data from community midwife deliveries.
5. A cost comparison study on delivery and intrapartum interventions, including but not limited to intravenous therapy, epidural anesthesia, supplementation, and length of hospital stay, should be undertaken to determine the potential for cost savings based of a change in policy regarding excess weight loss.
6. Studies examining the practice of elective caesarean delivery need to be completed in order to determine the additional risks to the mother and the infant, as well as the additional costs borne by the hospital from this method of delivery.

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## **APPENDICES**

**APPENDIX 1 – Data Collection Tool**

**APPENDIX 2 – McMaster University REB Letter of Approval**

**APPENDIX 3 – Brock University REB Letter of Approval**

**APPENDIX 4 – ROC Curve Analysis of Intravenous Therapy**

## APPENDIX 1 - Data Collection Tool

### Client Data

Date of Birth: \_\_\_\_\_

G \_\_\_\_\_ T \_\_\_\_\_ P \_\_\_\_\_ A \_\_\_\_\_ L \_\_\_\_\_

### Medical History:

Gestational Diabetes                      Yes                      No

PIH    Yes                      No

PCOS    Yes                      No

Maternal weight: \_\_\_\_\_ Maternal Weight gain during pregnancy: \_\_\_\_\_

Height: \_\_\_\_\_ BMI/stature: \_\_\_\_\_

Blood type: \_\_\_\_\_ Rh status: \_\_\_\_\_ Rhogam: \_\_\_\_\_

Fertility treatment                      Yes                      No

If yes, details:

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Meds:

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Other medical conditions:

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Attending:                                      OB/GYN                                      Midwife

Lab values (list)

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## **Labour**

Total Hours: \_\_\_\_\_

Hours in Hospital: \_\_\_\_\_

Membrane rupture:              Spontaneous                      Assisted

Induction:                      Yes                      No

If Yes,      Type: \_\_\_\_\_ Amount: \_\_\_\_\_ Time: \_\_\_\_\_

Method of Delivery:

                    Vaginal              Assisted Vaginal              Urgent C-section              Planned C-section

If Assisted Vaginal:              Forceps                      Vacuum

Epidural:                      Yes                      No

Duration: \_\_\_\_\_ Amount: \_\_\_\_\_

Analgesia:                      Yes                      No

Type: \_\_\_\_\_ Amount: \_\_\_\_\_

Fever:                      Yes                      No

Onset: \_\_\_\_\_ Duration: \_\_\_\_\_ Meds: \_\_\_\_\_

## **IV Therapy**

IV therapy                      Yes                      No

Type: \_\_\_\_\_

Rate: \_\_\_\_\_

Total Volume Infused: \_\_\_\_\_

Over total time: \_\_\_\_\_

Method:                      Gravity                      Pump

**Infant data**

Gender: Male Female

Gestation (weeks) \_\_\_\_\_

Birthweight: \_\_\_\_\_

Subsequent weights:

Date	Time	Age	Weight	Difference	% Loss

APGAR at birth: \_\_\_\_\_

at 5 minutes: \_\_\_\_\_

Fever: Yes No

Details: \_\_\_\_\_

Multiple (twin, triplet etc) Yes No

Hypoglycemia Yes No

Lab values:

Value/Date/time: \_\_\_\_\_

Hyperglycemia Yes No

**Lab values:**

Value/Date/time: \_\_\_\_\_

Hyperbillirubinemia	Yes	No
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Lab values:

Value/Date/time: \_\_\_\_\_

Hyponatremia	Yes	No
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Lab values:

Value/Date/time: \_\_\_\_\_

Hypernatremia	Yes	No
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Lab values:

Value/Date/time: \_\_\_\_\_

Meconium at birth	Yes	No
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Other Medical conditions, medications:

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**Infant Feeding Method** (choose ONE only)

Exclusive Breastfeeding (includes EBM)	Yes	No
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Was a Breastfeeding assessment completed?	Yes	No
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If yes, when: \_\_\_\_\_

Time of first feed (within hours of birth): \_\_\_\_\_

Frequency of feeds (q?h): \_\_\_\_\_

Amount of feeds: \_\_\_\_\_



Problems with feed (list):

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Breast and Formula

Yes

No

Time of first feed (within hours of birth): \_\_\_\_\_

Frequency of feeds (q?h): \_\_\_\_\_

Amount of feeds: \_\_\_\_\_

Problems with feed (list):

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Formula Only

Yes

No

Time of first feed (within hours of birth): \_\_\_\_\_

Frequency of feeds (q?h): \_\_\_\_\_

Amount of feeds: \_\_\_\_\_

Problems with feed (list):

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Special dietary considerations (i.e. Lactose, GERD)

Yes

No

List:

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## Appendix 2 – McMaster University REB Letter of Approval



Date: September 23, 2008

To: Kim Sheehan  
RN, Stonechurch Family Health Centre

From: Mary Bedek  
Chief Privacy Officer, HHS

### **Re: Research Ethics Board Application 08-444-C Final Approval**

Dear Kim Sheehan:

The above application for retrospective chart review has been reviewed by the REB Chair and the Chief Privacy Officer and has received Final Approval.

If you require a listing of chart identifiers for this project please contact the Decision Support Services Department who will be able to assist you with this data extraction.

Once you have the chart identifiers please submit the listing to the appropriate health records department and to the attention of the individuals listed below. Your records will be retrieved within 72 hours. Please note that a maximum of 20 records will be retrieved at a time, this is due to space limitations. As well, the records may not be removed from the Health Records Department.

If you require any type of computer assistance, including passwords please contact our ICT department.

Health Records Contacts for Research:

Site	Health Records
HGH	Elsie Soares
MUMC	Gillian Reader
Henderson	Linda Pati
Chedoke	Gillian Reader
Juravinski Cancer Centre	Linda Pati

At any time if you require assistance from Health Records with your research activities please contact one of the management staff listed above or the Manager of Health Records and Admitting, Trish Ladouecuer.

### Appendix 3 – Brock University REB Letter of Approval

**DATE:** December 12, 2008

**FROM:** Michelle McGinn, Chair  
Research Ethics Board (REB)

**TO:** Dr. M. Plyley, Research and Graduate Studies  
Kim Sheehan

**FILE:** 08-182 PLYLEY/SHEEHAN  
Masters Thesis/Project

**TITLE:** The relationship between intrapartum intravenous therapy  
and newborn weight loss

The Brock University Research Ethics Board has reviewed the above research proposal.

**DECISION:** ACCEPTED AS IS

This project has received ethics clearance for the period of **December 12, 2008 to June 30, 2009** subject to full REB ratification at the Research Ethics Board's next scheduled meeting. The clearance period may be extended upon request. ***The study may now proceed.***

Please note that the Research Ethics Board (REB) requires that you adhere to the protocol as last reviewed and cleared by the REB. During the course of research no deviations from, or changes to, the protocol, recruitment, or consent form may be initiated without prior written clearance from the REB. The Board must provide clearance for any modifications before they can be implemented. If you wish to modify your research project, please refer to <http://www.brocku.ca/researchservices/forms> to complete the appropriate form Revision or Modification to an Ongoing Application.

Adverse or unexpected events must be reported to the REB as soon as possible with an indication of how these events affect, in the view of the Principal Investigator, the safety of the participants and the continuation of the protocol.

If research participants are in the care of a health facility, at a school, or other institution or community organization, it is the responsibility of the Principal Investigator to ensure that the ethical guidelines and clearance of those facilities or institutions are obtained and filed with the REB prior to the initiation of any research protocols.

The Tri-Council Policy Statement requires that ongoing research be monitored. A Final Report is required for all projects upon completion of the project. Researchers with projects lasting more than one year are required to submit a Continuing Review Report annually. The Office of Research Services will contact you when this form *Continuing Review/Final Report* is required.

Please quote your REB file number on all future correspondence.

MM/an

## Appendix 4 – ROC Curve Analysis of Intravenous Therapy

### Coordinates of the Curve

Test Result Variable(s): Infusion volume (in millilitres)

Positive if Greater Than or Equal To <sup>a</sup>	Sensitivity	1 - Specificity
-1.00	1.000	1.000
200.00	.957	.833
450.00	.957	.815
600.00	.957	.796
850.00	.957	.778
1050.00	.957	.704
1150.00	.935	.667
1225.00	.913	.667
1275.00	.848	.648
1333.50	.826	.630
1383.50	.804	.630
1425.00	.783	.611
1475.00	.783	.593
1550.00	.783	.556
1650.00	.717	.556
1728.50	.696	.519
1759.50	.696	.500
1781.00	.696	.481
1825.00	.674	.481
1875.00	.674	.463
1925.00	.674	.444
1975.00	.674	.426
2050.00	.543	.370
2125.00	.522	.370
2160.50	.500	.315
2185.50	.478	.315
2225.00	.457	.315
2251.00	.391	.278

2276.00	.391	.259
2350.00	.370	.241
2475.00	.370	.204
2575.00	.326	.204
2675.00	.304	.204
2775.00	.304	.185
2900.00	.304	.167
3025.00	.283	.167
3064.50	.283	.130
3114.50	.283	.111
3175.00	.261	.111
3225.00	.261	.093
3425.00	.217	.074
3700.00	.217	.056
3823.50	.196	.056
3873.50	.174	.056
3950.00	.152	.056
4125.00	.065	.056
4435.50	.065	.037
4710.50	.043	.037
4900.00	.022	.037
5400.00	.022	.000
5801.00	.000	.000

The test result variable(s): Infusion volume in millilitres has at least one tie between the positive actual state group and the negative actual state group.

- a. The smallest cut-off value is the minimum observed test value minus 1, and the largest cut-off value is the maximum observed test value plus 1. All the other cut-off values are the averages of two consecutive ordered observed test values.